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ESR study of Co-doped TiO_2 thin films

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Abstract

Co:TiO_2 thin films prepared by reactive co-sputtering deposition were studied by electron spin resonance (ESR) technique. Magnetization measurements showed hysteretic behavior with the coercive field between 55 and 65 Oe and the saturation magnetization at room temperature ranging from 7 (2.2% Co) to 28 emu/cm^3 (8.5% Co). ESR measurements at X-band (9.5 GHz) revealed an anomaly in the temperature behavior of the absorption intensity near the temperature at 60 K. This behavior is attributed to an unconventional spin-glass-like behavior, which results from competition of long-range dipole–dipole interaction and anisotropy fields in ferromagnetic Co nanoparticles.
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1. Introduction

Investigations of spin-polarized transport have attracted much attention during recent years because of demands in information technology to enable faster processing and larger storage capacity. New spintronic devices are under study, which hybridize the existing semiconductors with highly spin-polarized magnetic materials [1–3]. Because of the problems with spin-polarized current injection from metallic ferromagnet to a semiconductor [4], considerable efforts have been recently concentrated on the development of ferromagnetic semiconductors, which would be easily integrable with conventional semiconductors and also be highly spin-polarized. In spite of obvious progress in this direction (see, for example, Ref. [5]) the problem to enhance the Curie temperature, T_c, well above the room temperature still remains actual [6]. In this context, recent report on the room temperature ferromagnetism in epitaxial Co-doped TiO_2 films by Matsumoto et al. is very interesting [7].

In this work, we report on the electron spin resonance (ESR) investigations of magnetic properties of Co-doped TiO_2 films, prepared by the reactive co-sputtering. The ESR measurements have been done in the wide range of temperatures, 10–300 K, and for different orientations of DC magnetic field with respect to the film plane. It is established that Co nanoparticles are magnetically ordered at room temperature. In addition, a pronounced anomaly in magnetic susceptibility has been observed in the temperature range 50–80 K, which is attributed to a spin-glass-like ordering in the system of cobalt nanoparticles.

2. Sample preparation and characterization

A set of Co-doped TiO_2 thin films with different Co content was prepared by reactive co-sputtering of Co

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